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Associations of family feeding and mealtime practices with children's overall diet quality: Results from a prospective population-based cohort

Yuchan Mou [a,b], Pauline W. Jansen [c,d], Hein Raat [e], Anh N. Nguyen [a,b], Trudy Voortman [a,*]

[a] Department of Epidemiology, Erasmus MC, University Medical Center Rotterdam, PO Box 2040, 3000, CA, Rotterdam, the Netherlands
[b] The Generation R Study Group, Erasmus MC, University Medical Center Rotterdam, PO Box 2040, 3000, CA, Rotterdam, the Netherlands
[c] Department of Child and Adolescent Psychiatry/Psychology, Erasmus MC, University Medical Center, PO Box 2060, 300, CB, Rotterdam, the Netherlands
[d] Department of Psychology, Education and Child Studies, Erasmus University Rotterdam, PO Box 1738, 3000, DR, Rotterdam, the Netherlands
[e] Department of Public Health, Erasmus MC, University Medical Center Rotterdam, PO Box 2040, 3000, CA, Rotterdam, the Netherlands

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ABSTRACT

Food parenting practices are considered to have a key influence on children's dietary habits, with potential long term effects. In this study, we explored the associations of parental feeding practices and family mealtime practices in early childhood with children's overall diet quality at school age among 3626 parents and their children in a population-based cohort study in Rotterdam, the Netherlands. Parental feeding practices (monitoring, pressure to eat, and restriction) and family mealtime practices (meal skipping behaviors and family meal frequency) at age 4 years were assessed by parental questionnaires. Children's dietary intake was assessed at age 8 years using a food-frequency questionnaire, from which diet quality scores (range 0–10) were calculated, reflecting adherence to age-specific dietary guidelines. Using multivariable linear regression models, we found that monitoring was associated with higher diet quality of children ($\beta = 0.12$; 95%CI: 0.08, 0.16), whereas pressure to eat was associated with lower diet quality ($\beta = -0.08$; 95%CI: −0.12, −0.04)), both independent of child BMI. Restriction was associated with a higher child diet quality, but this association was explained by child BMI. As compared to children who did not skip meals, children who skipped meals had a lower diet quality (e.g. breakfast skipping: $\beta = -0.32$; 95%CI: −0.48, −0.17). Similarly, children who had less frequent family meals had a lower diet quality compared with those who had family meals every day (e.g. family dinner $\leq$2 days/week: $\beta = -0.37$; 95%CI: −0.60, −0.14). These associations were not driven by single food groups. In conclusion, parental monitoring and family mealtime routines in early childhood may provide a supportive food environment that promotes children's overall diet quality. Longitudinal studies with repeated measurements are needed to replicate our findings.

1. Introduction[1]

Children's diet quality has been a key focus of health promotion and obesity prevention given the globally high prevalence of childhood overweight and obesity. A healthy diet in childhood is important for children's health and well-being, and it shapes lifelong dietary habits (Mikkilä, Räsänen, Raitakari, Pietinen, & Viikari, 2005). Yet, the overall diet quality of school-aged children in many developed countries is suboptimal (U. S. Department of Agriculture, 2016; Carlson, Lino, Gerrior, & Basiotis, 2003; Jennings, Welch, van Sluijs, Griffin, & Cassidy, 2011; van der Velde et al., 2018), and the family food environment is assumed to have the foremost influential impact (Leann Lipps Birch & Davison, 2001; Rosenkranz & Dzewaltowski, 2008). Across the globe, children and adolescents generally consume two-third of their food intake at home (Adair & Popkin, 2005), presumably with their parents. Thus, it is important to evaluate the effect of family feeding practices and mealtime practices as the food parenting aspect of family food environment on child diet quality.

There are three commonly used controlling feeding practices described in the literature: monitoring, i.e., cautiously keeping track of what children eat; pressure to eat, i.e., attempting to improve the quantity or quality of children's food intakes; and restriction, i.e., regulating the type and amount of food eaten by children (L. L. Birch et al., 2001). These feeding practices are clearly related to children's

* Corresponding author.
E-mail address: trudy.voortman@erasmusmc.nl (T. Voortman).

[1] Abbreviations: CFQ, Child Feeding Questionnaire; FFQ, Food Frequency Questionnaire; BMI, body mass index; SD, standard deviation; IQR, interquartile range.

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food preferences (Leann Lipps Birch, Marlin, & Rotter, 1984, pp. 431–439; Leann Lipps Birch, McPheee, Shoba, Steinberg, & Krehbiel, 1987), as well as weight status in early childhood (Leann L. Birch & Fisher, 2000; Jansen et al., 2012). Similarly, some studies implicated that the use of these feeding practices is associated with children's diet quality. For instance, higher levels of monitoring have been associated with higher intake of fiber, lower intake of added sugar (J. S. Gubbels et al., 2011), and with a lower likelihood of having an inadequate intake of fruit and vegetables (Durão et al., 2015); higher level of pressure to eat has been linked to a higher likelihood of having an adequate intake of diary (Durão et al., 2015), and lower number of food consumed considered to be healthy (Jani, Mallan, & Daniels, 2015); and more restriction has been related to higher frequency of vegetable and fruit intake (Durão et al., 2015; Jessica S.; Gubbels et al., 2009; Park, Li, & Birch, 2015), and lower energy dense food intake (Durão et al., 2015).

In addition to parental feeding practices, family mealtime practices have also been suggested to be an important determinant of child and adolescent diet quality and obesity risk. For instance, meal skipping was associated with a lower intake of vegetables, grains, and milk products and higher body fat in preschool children (Dubois, Girard, Kent, Farmer, & Tatone-Tokuda, 2009; Wijtzes et al., 2016). Higher frequency of family meals has been linked to healthful food and nutrient intake and a normal weight range in youth (Gillman et al., 2000; Hammons & Fiese, 2011; Welsh, French, & Wall, 2011). Yet, those previous studies mainly focused on intake of specific food groups or nutrients, and conclusions regarding effects on children's diet quality are difficult to make due to the limitation of using food intake frequency or only a selected food group as a proxy to diet quality in previous studies. Intake of healthy foods is not necessarily inversely related to unhealthy food intake (Anderson, Ramsden, & Kaye, 2016), suggesting that it is important to investigate the overall dietary pattern. Studying the overall diet gives a complementary indication of a healthy and balanced diet than focusing solely on specific food groups.

There are a few studies on concurrent associations of feeding practices, family mealtime practices and children's overall diet quality (Couch, Glanz, Zhou, Sallis, & Saelens, 2014; Ramsay et al., 2018; Woodruff, Hanning, McGoldrick, & Brown, 2010). However, effects of parental feeding and mealtime practices in early childhood may carry forward into later childhood (Larsen et al., 2015). In this study, we aimed to explore the relationships of parental feeding practices (restriction, pressure to eat and monitoring) and mealtime practices (meal skipping behaviors and family meal frequency) in early childhood with overall diet quality of children at school age in a population-based cohort. Considering that child BMI may be an antecedent of feeding practices (Jansen et al., 2014), we additionally assessed whether the associations were independent of child BMI. We hypothesized that there would be positive associations of restriction and monitoring with children's overall diet quality, and negative associations of pressure to eat, meal skipping behaviors and less frequent family meals with children's overall diet quality and that these associations are independent of child BMI.

2. Methods

2.1. Study design and population

This study was embedded in The Generation R Study, a prospective population-based cohort from fetal life onwards which is designed to identify early environmental and genetic determinants of growth, development and health during the life course. Eligible participants for this study were pregnant women with a delivery date from April 2002 through January 2006 living in Rotterdam, the Netherlands (baseline response rate: 61%) (Kooijman et al., 2016). The study was approved by the Medical Ethics Committee of the Erasmus Medical Center, Rotterdam. Written informed consent was obtained from all participating children and their parents. In total, 6625 children and their parents gave full consent for the preschool phase. We excluded children of mothers who did not receive the CFQ at the age of 4 years due to logistic problem (n = 282) and those without data on any of the subscales of feeding practices and family eating practices at the age of 4 years (n = 1687). From this group, we additionally excluded children who have missing data (n = 1005) or invalid data (n = 25) on the FFQ at 8 years of age. The final study population consisted of 3626 mother-child dyads (Supplemental Fig. 1). The sample included 340 siblings. The majority of children in the sample were first (57.8%) and second (28.8%) born. Children with food allergies were included in the sample, as previous results showed no associations of food allergies with diet quality in this population (Nguyen et al., 2017). Children who did not eat meat were also included, however, there were no children with a vegan dietary pattern in the sample. Comparison of the respondents (n = 3626) and non-respondents to the FFQ (n = 1030) showed that data were more often missing among children with a higher BMI at age 3 years, with younger, non-Dutch, low educated mothers, and with low household incomes. There were no differences with respect to scores of feeding practices, meal skipping and frequency of family meals those who did and did not fill out the FFQ (data not shown).

2.2. Measures

All questionnaires were available in three languages (Dutch, English and Turkish). Staff from different national origins were available to verbally translate questionnaires into Arabic, French and Portuguese. As such, the study staff were able to communicate with all participants.

2.2.1. Parental feeding practices

Feeding practices were assessed with the CFQ, which is a self-report measure for parents of 2–11 year old children to assess parental beliefs, attitudes and strategies regarding child feeding (L. L. Birch et al., 2001). Parents were asked to fill out the postal questionnaires shortly after their child's fourth birthday. Assessed subscales include monitoring (3 items), pressure to eat (4 items), and restriction (8 items). Sample items are "How much do you keep track of the high-fat foods that your child eats?" (monitoring), "I have to be especially careful to make sure that my child eats enough" (pressure to eat), and "I intentionally keep some foods out of my child's reach" (restriction). Items were answered on a five-point Likert scale from 1 = never/disagree to 5 = always/agree, and summed per subscale. For children whose parents partially answered the items, weighted subscale sum scores were calculated if at least 75% of the items of a subscale was answered. The CFQ was mostly completed by mothers (88.4%). Research provided evidence for adequate validity and reliability of the CFQ with actual observations of maternal feeding behavior (L. L. Birch et al., 2001). In the current study population, the internal consistencies of the CFQ scales were moderate (restriction: $\alpha = 0.73$, pressure to eat: $\alpha = 0.65$) to high (monitoring: $\alpha = 0.91$).

2.2.2. Family mealtime practices

Measures of family mealtime practices consisted of meal skipping behaviors and family meal frequency. Children's consumption of breakfast, lunch, dinner and frequency of eating breakfast/dinner together with at least one parent in an average week were assessed individually by single-item questions in a parent-reported questionnaire when children were 4 years of age. Sample items are 'How often does your child eat breakfast?' (breakfast skipping), and 'How often do you have breakfast around the table together with your childr(en)?' (family breakfast frequency). Answering options include never, 1–2 days/week, 3–4 days/week, 5–6 days/weeks, and every day. We defined meal skipping behaviors as present if breakfast, lunch or dinner skipping occurred at least once in a week versus never, because of highly skewed distributions. Family breakfast and dinner frequency were grouped into three categories: $\leq$2 days/week, 3–6 days/week and Every day.

2.2.3. Diet quality in mid-childhood

Food intake was assessed when children were about 8 years old. Parents completed a validated age-specific semi-quantitative FFQ (van der Velde et al., 2018), using the last 4 weeks as reference period. The FFQ was mostly completed by mothers (86.2%). The FFQ was developed based on results from a National Food Consumption Survey in the Netherlands, which resulted in the selection of 71 food items relevant for the energy intake of 2 to 12-year-old children. Questions concerned the frequency of consumption and portion sizes of these foods. Additional questions about specific types or brands and preparation methods were asked for 27 foods. Portion sizes were assessed in natural units, household units or grams, and parents were asked to measure the volume of glasses and cups regularly used by their child. Information on frequencies, types and portion sizes was converted into grams of individual food items per day based on standard Dutch portion sizes, using SAS VoVris (Vovris V2.4, TNO, 1999–2006). Energy intake from foods was calculated using data from the Dutch Food Composition Table (NEVO 2001) with SAS Veves (Veves V2.2, TNO, 1993–2003). The FFQ has been validated for energy intake among 4 to 6-year-old Dutch children ($n = 30$) using the doubly labeled water method ($r = 0.62$) (Dutman et al., 2011).

Diet quality of children was quantified by a predefined food-based diet quality score, based on Dutch dietary recommendations for 8-year-old children (Netherlands Nutrition Center, 2016; The Health Council of the Statistics Netherlands, 2015). The detailed information is reported elsewhere (van der Velde et al., 2018). Briefly, this diet quality score consisted of 10 components, including fruit (≥150 g/d); vegetables (≥150 g/d); whole grains (≥90 g/d); fish (≥60g/w); legumes (≥84g/w); nuts (≥15 g/d); dairy (≥300 g/d); oils and soft or liquid margarines (≥30 g/d); sugar-containing beverages (≤150 g/d); and high-fat and processed meat (≤250g/w). For each component, the ratio of reported and recommended intake was calculated. For example, a vegetable intake of 90 g/day resulted in a score of 0.6 (90 divided by 150g/day) for this component. For sugar-containing beverages and high-fat and processed meat, this scoring system was reversed, with higher scores reflecting lower intakes. For example, a high-fat and processed meat intake of 45g/day resulted in a score of 0.7 (1-(45 divided by 150 g/day)). Scores per food component of above 1 were truncated to 1. For instance, a vegetable intake of 160g/day (160 divided by 150g/day) resulted in a score of 1. Scores of the individual components were summed, resulting in a total score ranging from 0 to 10 on a continuous scale, with higher scores reflecting better adherence to the dietary guidelines. The diet quality score was validated for intake of several macronutrients and micronutrients within children participating in the Generation R Study (van der Velde et al., 2018).

2.2.4. Covariates

Several child and parental characteristics were considered as possible confounders in the association between parental feeding practices, family meal practices and child diet quality based on prior literature (J. M. Berge et al., 2018; Jansen et al., 2014; Nguyen et al., 2019; van der Velde et al., 2018; Wijtzes et al., 2016). Child sex was derived from medical records filled in by obstetricians and community midwives. Height and weight were measured by trained staff at the municipal Child Health Centers as part of routine health care when children were 3 years old. Child's sex- and age-adjusted BMI (kg/m^2) SD score were calculated using Dutch reference growth curves (Fredriks et al., 2000). Information on maternal ethnic background, education level and household income were obtained by questionnaires at enrollment. Ethnic background was categorized into Dutch and non-Dutch based on country of birth of the parents, according to Statistics Netherlands (Statistics Netherlands, 2015). Maternal highest education level was categorized into low (ranging from no education up to lower vocational training) and high (higher vocational training/university) educational level. Household income was dichotomized into <2200 € and ≥2200 € per month.

2.3. Statistical analyses

Characteristics of the study population were described as mean (SD) for continuous and normally distributed variables, median (IQR) for continuous variables with a skewed distribution, or percentage for categorical variables. Parental feeding practices were standardized to facilitate effect sizes comparison, these scores can be interpreted as SD scores.

We examined the associations while taking into account covariates by multiple linear regression models. Separate regressions were conducted for five predictors separately (feeding practices: restriction, monitoring, pressure to eat; mealtime practices: meal skipping behaviors and family meal frequency), each with diet quality as the outcome. For each predictor, analyses were performed using four models. Model 1 included the predictor as well as child sex, age and overall energy intake. In model 2, we additionally adjusted for sociodemographic factors: maternal ethnic background, education and household income. Model 3 was additionally adjusted for child BMI-SD score at 3 years. To determine the interdependence of the feeding practices, all three feeding practices were simultaneously included in a model 4. To determine interdependence of meal skipping behaviors with family meal frequency, we also performed a model 4 including both breakfast skipping and family breakfast frequency (and similarly for dinner practices). Results with a P value < 0.05 were considered significant. To reduce potential bias due to missing data on covariates (ranging from 0.1% of missing values in child age at FFQ assessment to 25.3% missing values in child BMI at 3 years), we applied multiple imputations by generating 30 independent datasets using the Markov chain Monte Carlo method. Analyses were based on pooled results of imputed datasets. For all associations, we examined interactions of each of the predictors with sex and weight status at the age of 3 years. We also examined the interaction between the feeding practices and family meal frequency in model 3. Additionally, we examined non-linearity of the associations by including a natural cubic spline line with 3 knots.

We performed several sensitivity analyses to test whether the associations were robust, all based on model 3 in the main analyses. First, non-imputed data was used in the analyses to assess whether the imputations and non-response influenced our findings. Second, to evaluate if certain food components were driving the relations, the associations of parental feeding practices and family meal practices with the ten food component scores were examined separately as post-hoc analyses. Due to skewed distributions of many of the food component scores, each food component score was categorized into tertiles and ordinal logistic regression models were used to analyze the associations. Third, analyses were performed among children of mothers with a Dutch ethnic background only, because the FFQ was developed and validated for Dutch populations.

All statistical analyses were performed with R version 3.6.1 (R Foundation for Statistical Computing, Vienna, Austria).

3. Results

3.1. Population characteristics

Table 1 shows the characteristics of the 3626 mothers and their children. Mean ± SD overall diet quality score of children at 8 years was 4.6 ± 1.2 (out of a theoretical range from 0 to 10). The prevalence of meal skipping behaviors ranged from 6.2% to 6.5% in the sample. The majority of parents had breakfast (52.5%) and dinner (78.4%) with their child every day. Mothers of children in the study population were mostly of Dutch ethnic background and relatively highly educated. The information of non-imputed and imputed data is shown in Supplemental Table 1, suggesting that the imputed data are similar to the original data.

Table 1
Characteristics of study population (n = 3626).

	Mean ± SD, median (IQR) or no. (%)[a]
Maternal characteristics	
Ethnic background (non-Dutch)	1064 (29.3)
Educational level (Low)	1036 (28.6)
Household income (< 2200 €)	1028 (28.4)
Feeding practices at age 4 years [b]	
Restriction score	24 (6)
Monitoring score	15 (12, 15)
Pressure to eat score	12 (4)
Family mealtime practices at age 4 years	
Breakfast skipping (yes)	235 (6.5)
Lunch skipping (yes)	236 (6.2)
Dinner skipping (yes)	232 (6.4)
Family breakfast frequency	
Every day	1903 (52.5)
3–6 days/week	904 (24.9)
≤2 days/week	819 (22.6)
Family dinner frequency	
Every day	2842 (78.4)
3–6 days/week	688 (19.0)
≤2 days/week	96 (2.6)
Child characteristics	
Age at CFQ assessment (y)	4.0 (4.0, 4.1)
Age at FFQ assessment (y)	8.1 (8.0, 8.2)
Sex (Girls)	1846 (50.9)
BMI SD Score at 3 years	0.1 ± 0.9
Overall diet quality score at 8 years	4.6 ± 1.2
Energy intake (Kcal) at 8 years	1484 ± 362

[a] Values are mean ± SD for continuous variables with a normal distribution, medians (IQR) for continuous variables with a skewed distribution, or valid numbers (%) for categorical variables. Missing data of covariates (ranging from 0.2% to 25.3%, Supplement Table 1) were imputed with multiple imputation (M = 30 imputations).
[b] The minimum and maximum scores of the feeding practices are: restriction (8, 40), monitoring (3, 15), pressure to eat (4, 20).

3.2. Associations of parental feeding practices and family mealtime practices with children's overall diet quality

We performed linear regression models with splines including non-linear association and interaction of feeding practices with sex, weight status or family meal frequency. None of the feeding practices showed a significant interaction with sex, weight status or family meal frequency on diet quality (all $p > 0.05$). There were no indications for non-linear associations of restriction and monitoring with child's diet quality ($p > 0.05$), but there was for pressure to eat ($p < 0.001$). We observed that the inverse association of pressure to eat with diet quality plateaued at higher levels of pressure (Supplemental Fig. 2), representing an approximation of a linear association. Therefore, we used linear models for all main analyses.

Table 2 shows that restriction and monitoring were associated with higher overall diet quality scores of children (restriction: β = 0.05, 95% CI 0.01, 0.08; monitoring: β = 0.12, 95% CI 0.08, 0.17), while pressure to eat was associated with a lower overall diet quality score (β = −0.10, 95% CI −0.13, −0.06), independently of sociodemographic variables (Model 2). After additional adjustment for children's BMI SD score at age 3 years (Model 3), the effect of restriction became non-significant. In contrast, the associations of monitoring and pressure to eat with children's diet quality remained significant (monitoring: β = 0.12, 95%CI 0.08, 0.16; pressure to eat: β = −0.08, 95%CI −0.12, −0.04). In the analyses that accounted for the dependence of three feeding practices, results did not change meaningfully, suggesting that the feeding practices are associated with children's diet quality independent of each other (Model 4).

The associations of family mealtime practices with children's overall diet quality are presented in Table 3. Regarding meal skipping behaviors, we found that children who skipped a meal occasionally at age 4 years had lower diet quality scores at 8 years (Model 2. E.g., breakfast skipping: β = −0.32, 95%CI −0.48, −0.17). Furthermore, children whose parent had breakfast or dinner with them on fewer days had lower diet quality. (Model 2. E.g. family dinner≤2 days/week: β = −0.37, 95%CI: −0.60, −0.14). Additional adjustment for child BMI at 3 years did not change these results (Model 3). Likewise, the associations of family breakfast and dinner frequency remained similar when accounting for breakfast and dinner skipping respectively (Model 4).

Table 2
Associations between parental feeding practices at 4 years and children's overall diet quality at 8 years (n = 3626)[a].

Feeding practices (per SD)	Overall Diet quality scores			
	Model 1	Model 2	Model 3	Model 4
	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)
Restriction	**0.05 (0.01, 0.08)**	**0.05 (0.01, 0.08)**	0.03 (−0.004, 0.07)	0.04 (−0.001, 0.08)
Monitoring	**0.16 (0.11, 0.20)**	**0.12 (0.08, 0.17)**	**0.12 (0.08, 0.16)**	**0.12 (0.07, 0.16)**
Pressure to eat	**−0.13 (-0.17, -0.09)**	**−0.10 (-0.13, -0.06)**	**−0.08 (-0.12, -0.04)**	**−0.08 (-0.12, -0.04)**

Model 1: adjusted for child's sex, age and energy intake at the FFQ assessment.
Model 2: model 1 additionally adjusted for maternal ethnic background, maternal education, household income.
Model 3: model 2 additionally adjusted for child's BMI SD scores at 3 years.
Model 4: model 3 additionally adjusted for other feeding practices.
* Statistical significance ($p < 0.05$) is indicated with **bold**.
[a] Values are β coefficients and 95% confidence intervals (CI) from linear models, and represent differences in diet quality scores per one SD change of feeding practices.

3.3. Additional analyses

Analyses with non-imputed data showed similar results as for imputed data (data not shown). Results of associations with children's food component scores are shown in Supplemental Tables 2, 3, and 4. In general, associations of each practice with most food component scores were in similar directions as for the overall diet quality score, and no particular food component score was found to drive the association. Analyses including mothers with a Dutch ethnic background only also represented similar results compared to the whole study population (Supplemental Tables 5 and 6), except that associations of meal skipping behaviors with child's diet quality were smaller, whereas associations of family breakfast/dinner frequency with child's diet quality were larger compared to the whole group.

4. Discussion

To our knowledge, this is the first study to show temporal associations of feeding and mealtime practices with overall diet quality in childhood. In this population-based prospective cohort, we observed that parental restriction and monitoring at child age 4 years were linked to a higher overall diet quality of children at age 8 years. Pressure to eat, meal skipping and less frequent family meals were associated with a lower overall diet quality of children. The magnitude of these effects may be small at a population level but still reflects meaningful individual differences. For instance, children who were only little monitored as a preschooler (−2 SD) compared to those who were highly monitored (+2 SD) had on average half a unit of diet quality score, which indicates half of recommended daily intake in one of the food components. Importantly, these associations were not driven by single food components, suggesting an influence of feeding practices and mealtime practices on overall children's food consumption patterns.

Several previous studies found that parental monitoring was positively associated with children's healthy food or nutrient intake. For

Table 3
Associations between family mealtime practices at the age of 4 years and children's overall diet quality at the age of 8 years (n = 3626)[a].

Family mealtime practices	Overall diet quality scores			
	Model 1	Model 2	Model 3	Model 4
	β (95%CI)	β (95%CI)	β (95%CI)	β (95%CI)
Meal skipping behaviors [b]				
Breakfast skipping (yes)	**−0.42 (-0.57, -0.26)**	**−0.32 (-0.48, -0.17)**	**−0.32 (-0.48, -0.17)**	−0.22 (−0.38, 0.07)
Lunch skipping (yes)	**−0.35 (-0.50, -0.19)**	**−0.27 (-0.42, -0.11)**	**−0.28 (-0.43, -0.12)**	-[c]
Dinner skipping (yes)	**−0.35 (-0.50, -0.19)**	**−0.30 (-0.45, -0.15)**	**−0.30 (-0.45, -0.14)**	**−0.27 (-0.43, -0.12)**
Family meal frequency				
Family breakfast frequency				
Every day	Reference	Reference	Reference	Reference
3–6 days/week	**−0.15 (-0.24, -0.06)**	**−0.14 (-0.23, -0.05)**	**−0.14 (-0.23, -0.05)**	**−0.12 (-0.21, -0.03)**
≤2 days/week	**−0.46 (-0.56, -0.37)**	**−0.40 (-0.50, -0.31)**	**−0.40 (-0.50, -0.31)**	**−0.38 (-0.48, -0.29)**
Family dinner frequency				
Every day	Reference	Reference	Reference	Reference
3–6 days/week	−0.04 (−0.14, 0.05)	−0.06 (−0.16, 0.03)	−0.06 (−0.16, 0.04)	−0.04 (−0.13, 0.06)
≤2 days/week	**−0.39 (-0.63, -0.16)**	**−0.37 (-0.60, -0.14)**	**−0.37 (-0.61, -0.14)**	**−0.34 (-0.57, -0.10)**

Model 1: adjusted for child sex, age and energy intake at FFQ questionnaire.
Model 2: model 1 additionally adjusted for maternal ethnic background, maternal education, household income.
Model 3: model 2 additionally adjusted for child's BMI SD scores at 3 years.
Model 4: models for family breakfast and dinner frequency additionally adjusted for breakfast and dinner skipping behaviors respectively.
* Statistical significance ($p < 0.05$) is indicated with **bold**.
[a] Values are β coefficients and 95% CI from linear models. The values of each meal skipping represent differences in diet quality scores of children who had meal skipping behaviors compared those who didn't have. The values of each family meal frequency represent differences in diet quality scores of children who had meal with at least one parent ≤2 days/week or 3–6 days/week compared to those who had family meal every day.
[b] Meal skipping behaviors were defined as consumption of meal less than 7 days per week.
[c] Not applicable for lunch skipping.

instance, research found associations of monitoring with higher fiber intake and lower added sugar intake among 4–8 years children (J. S. Gubbels et al., 2011; Haszard, Skidmore, Williams, & Taylor, 2015). Our findings complement this evidence by showing that monitoring predicted higher overall diet quality. Although parental monitoring has not been examined much, two studies showed that permissive parenting around child eating was negatively associated with overall diet quality (Couch et al., 2014; Lopez et al., 2018), while authoritative parenting was positively associated with diet quality score of children at age 10 years (Lopez et al., 2018). These findings are consistent with our results, considering that feeding practices and parenting styles are inextricably linked: parents who monitor the food consumption patterns of their children are generally less permissive and more authoritative (Blissett & Haycraft, 2008; Collins, Duncanson, & Burrows, 2014; Hubbs-Tait, Kennedy, Page, Topham, & Harrist, 2008; Hughes, Power, Fisher, Mueller, & Nicklas, 2005). Potentially, these parents may influence child eating in a rather implicit way, for instance by providing a healthy food environment, encouraging children to eat healthy food, and by being role models who eat healthily themselves (Faught, Vander Ploeg, Chu, Storey, & Veugelers, 2016; Vaughn, Martin, & Ward, 2018).

We found that pressuring feeding practice was associated with poorer overall diet quality in later childhood, which is in concordance with previous studies reporting associations of pressure to eat with lower fruit and vegetable intake among 5-year old girls (Orlet Fisher, Mitchell, Wright, & Birch, 2002) and among 2-6 year-old children (Wardle, Carnell, & Cooke, 2005), and 6–11 year old children (Couch et al., 2014). In contrast, although the latter study did report associations of pressure to eat with lower fruit and vegetable intake, they found no relationship between pressure to eat and overall diet quality when adjusting for other home food environment scales among children aged 6–11 years (Couch et al., 2014). The difference in findings for diet quality might be explained by the latter study assessing pressure to eat at school ages, when a potential effect of parental feeding styles may become smaller. The effect of parent's pressuring feeding strategies may gradually decrease when children become more independent and also eat more in different school and social settings. Second, they adjusted for other aspects of sociocultural and physical environment scales in home food environment in the analyses, which are suggested to be mediators in the effect of feeding practices on children's dietary behavior (Larsen et al., 2015). Our finding that pressure to eat was associated with a poorer diet quality is in line with studies arguing that the practice has a counterproductive effect, as it may increase food avoidance of children (Galloway, Fiorito, Francis, & Birch, 2006). Alternatively, it could also be that the children whose parents pressure them to eat already had a poor diet quality (Mallan et al., 2018).

Our finding that parental restriction was associated with higher child diet quality concurs with a previous study showing that restriction was linked to desirable food intake of 2-year-old children (Jessica S. Gubbels et al., 2009). Another study among children, however, found restriction to be counterproductive for child snack intake (Blaine, Kachurak, Davison, Klabunde, & Fisher, 2017), leading to the conclusion that restriction was linked to a poor diet quality. These findings may not be contradictory given that the consumption of unhealthy food items is generally not inversely associated with healthy food consumption (Anderson et al., 2016). Regarding overall diet quality, Couch et al. found no association of restrictive feeding practices with child diet quality among 6–11 years children (Couch et al., 2014). Moreover, these results might be affected by the age of children when feeding practices were measured, because school-aged children eat more independently than younger children.

Considering previous findings that child BMI may be an antecedent of feeding practices (Jansen et al., 2014) and the strong link of diet quality with BMI, we also conducted analyses adjusting for children's BMI at age 3 years. Parental use of monitoring and pressure to eat remained significantly associated with child's overall diet quality, independent of child BMI. Yet, the association between restriction and child overall diet quality attenuated and became non-significant after adjusting for child BMI. This fits a previous finding (Derks et al., 2017), which showed that parental restriction at age 10 years was a response to a relatively high BMI at age 4 years, and is in line with the "child-responsive" model (Webber, Cooke, & Wardle, 2010; Webber, Hill, Cooke, Carnell, & Wardle, 2010).

In line with observational studies that reported the associations of meal skipping and undesirable dietary intake of children (e.g., less grains, vegetables and fruit intake, more unhealthy snacks intake) (Dubois et al., 2009; Pourrostami et al., 2019), we found that meal skipping behaviors were associated with lower overall diet quality. In the Netherlands, school-aged children generally have breakfast and dinner at home. Lunch is either eaten at home or taken from home to eat at school. Surely, each meal eaten adds to calories consumed. Yet, the associations were independent of energy intake and of antecedent BMI, which can also be seen as a proxy of several lifestyle factors. Breakfast as the most commonly skipped meal has received much attention in research. It has been suggested that breakfast consumption is beneficial for body composition and metabolic outcomes in the pediatric population (Koletzko & Toschke, 2010; Monzani et al., 2019; Wijtzes et al., 2016), as well as for cognitive and academic performance (Rampersaud, Pereira, Girard, Adams, & Metzl, 2005). Our findings shows that breakfast skipping was also related to poor diet quality. In addition, diet quality has been associated with more beneficial body composition (Nguyen et al., 2019), suggesting a pathway of breakfast skipping through overall diet quality on body composition. Potentially, children who skip breakfast are more likely to consume unhealthy, and energy-dense foods throughout the rest of the day (Utter, Scragg, Mhurchu, & Schaaf, 2007), which may undermine innate appetite control, leading to a increased energy intake (Johnson, Mander, Jones, Emmett, & Jebb, 2008). Furthermore, we found lunch and dinner skipping had similar effect estimates as breakfast skipping. However, research on the associations between lunch and dinner skipping with body composition is scarce and inconsistent (Vik et al., 2013; Wijtzes et al., 2016). This may be explained by the relatively lower frequency of lunch and dinner skipping compared to breakfast skipping. Nevertheless, it may hamper the overall balanced diet of children, thus have an influence on metabolism in children.

For family meal frequency, our findings are in accordance with previous studies reporting that eating family meals were associated with healthier food intake in school-aged children and adolescents, e.g., higher intake of fruit and vegetables, lower intake of sugar-sweetened beverages (Fink, Racine, Mueffelmann, Dean, & Herman-Smith, 2014; Gillman et al., 2000; Neumark-Sztainer, Hannan, Story, Croll, & Perry, 2003), but not for younger children (below 6 years) (Fink et al., 2014; Sweetman, McGowan, Croker, & Cooke, 2011). One study found a positive association between family dinner and overall diet quality among slightly older children, similar to our study (Woodruff et al., 2010). One way that family meals could improve diet quality is that a family meal contains foods that are healthier than children and adolescents would eat without parents (Skafida, 2013). Another explanation is that eating together as a family may have potential long-term beneficial effects on child diet quality. A study found that children who have frequent family dinner would more likely to have healthful food intake when they gain more independence on food selection and meal preparation (Fink et al., 2014). Potential mechanisms underlying the association may lie in parent-child interaction during family meals. Parents reported many benefits of family meals, including family cohesion, socialization, and shared nutritional knowledge (Fulkerson, Story, Neumark-Sztainer, & Rydell, 2008). Furthermore, parents who eat with their children during mealtimes may create a supportive eating environment by modeling eating behaviors and food choices (Jerica M. Berge et al., 2015; Vaughn et al., 2018), and by imposing family food rules (Couch et al., 2014) that would promote a better diet quality of children. Besides, frequent family meals may provide children with a habitual eating routine. Alternatively, parents who have more frequent family meals may be more aware of dietary guidelines or of the benefits of a healthy diet, and therefore have an influence on their children's diet quality. Future study should examine whether health consciousness of parents is on the pathway between family mealtime practices and child diet quality.

The strengths of this study are its population-based, longitudinal design, the large sample size, and the availability of data on several covariates. Moreover, we captured a broad picture of food parenting practices in the family context. Several limitations should be considered as well. First, both exposures and outcomes were parent-reported in our study, which could have led to reporter bias. Second, we cannot rule out temporal and dynamic changes in feeding practices and family mealtime structures over the time period of our study. However, previous studies indicated that feeding practices and family mealtime practices were relatively stable and showed continuity in childhood (Eichler et al., 2019; Wijtzes et al., 2016). Therefore, the validity of the results is less likely affected by the changes. Future studies with shorter time intervals between follow-up assessments are needed to capture these changes and also to study potential bi-directionality in parent-child interactions. Such studies would also allow us to better infer any causal effects. Third, a general limitation of FFQs is that they rely on memory and that reported intakes are subject to measurement error (Freedman, Schatzkin, Midthune, & Kipnis, 2011). However, the FFQ used in our study was validated against the doubly labeled water method in Dutch children and showed a reasonable capacity of ranking participants with respect to energy intake (Dutman et al., 2011). Fourth, there may be differences in diet composition across ethnicities. However, we previously reported no major differences in diet quality between ethnic groups in our cohort (van der Velde et al., 2018) and we performed a sensitivity analysis restricted to mothers with a Dutch ethnic background, for which the results were similar compared to the whole study population. Fifth, although we had information on several confounding factors, the possibility of residual confounding cannot be ruled out because of the observational nature of this study, such as mother's food preferences, children's autonomy in food choices and family functioning. Furthermore, comparison of the FFQ and CFQ between non-respondents and respondents showed differences in sociodemographic factors which may lead to biased estimations if associations differ between different sociodemographic groups.

5. Conclusion

Parents shape their family food environment by using different child feeding practices and family mealtime practices, which likely influence dietary habits of their children. Although further research is needed to prove causal effects, our findings suggest that parental monitoring, not using pressure to eat, less meal skipping and more frequent family meals may provide a supporting context to promote children's overall diet quality. Making parents aware of the potential long-term impacts of parenting practices around meals may be beneficial in improving children's diets. As we found that the associations were not driven by certain food groups, future studies should be cautious of using a single food group as an index of diet quality. More studies with repeated measurements of familial feeding and mealtime practices would enable a better understanding of children's development of dietary habits in a changing context, and to determine the direction of effects between parenting practices around meals and children's diet quality.

Declaration of competing interest

Y. Mou, P. W. Jansen, H. Raat, A. N. Nguyen, and T. Voortman, no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2020.105083.

Ethical statement

This study was embedded in The Generation R Study, a population-based prospective cohort from fetal life until young adulthood which is designed to identify early environmental and genetic determinants of growth, development and health during the life course. The Generation R Study was approved by the Medical Ethics Committee of the Erasmus

Medical Center, Rotterdam. Written informed consent was obtained from all participating children and their parents.

Author contributions

YM, PWJ and TV designed research; YM analyzed data; PWJ, HR, ANN, and TV provided consultation regarding the analyses and interpretation of data; YM wrote the paper; YM and TV had primary responsibility for final content. All authors read and approved the final submitted version.

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